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(19)

(54) A THERMOSTATICALLY CONTROLLED MIXER FITTING FOR HOT AND COLD WATER

(71) We, HANSA METALLWERKE AKTIENGESELLSCHAFT, a German Company of 7000 Stuttgart-Möhringen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a thermostatically controlled mixer fitting for hot and cold water of the kind comprising an adjustable thermostat insertable into the body of the fitting from the front and a pressure equalisation unit including a control member exposed to the pressure in each of the two supply chambers and adapted to regulate the cross sections of flow for the hot and cold water according to the pressure difference between the two supplies.

It is the object of the present invention so to contrive a mixer fitting of the specified kind that it is easy to manufacture and to which repairs can be conveniently effected.

According to the invention there is provided a thermostatically controlled mixer fitting for hot and cold water adapted to be fitted in or adjacent to a wall and including a thermostat which is adapted to be preset from a first side of the casing of the mixer fitting, said first side, when the fitting is fixed in operative condition, being adapted to face away from the wall, and which thermostat comprises a mounting sleeve containing an associated temperature-responsive element and coaxially with the latter regulating element for adjusting the supply of hot and cold water, the thermostat being insertable from the said first side into a mixing chamber of the casing and the fitting also including a pressure-balancing unit for regulating the flow rates of the hot and cold water streams according to their pressure differential, the pressure-balancing unit comprising a mounting sleeve-containing a diaphragm which is subjected in use, to the pressures of the two streams of hot and cold water and which controls a flow regulating member also located in the latter sleeve, the pressure-balancing unit being insertable into the mixer body with its axis parallel with the thermostat and from the same side as the thermostat.

Owing to this form of construction the thermostat and the pressure-balancing or equalisation unit become independently replaceable and can be easily fitted and removed.

In a further advantageous arrangement, there is provided an entry stop valve, a dirt intercepting filter and a flow-back preventor in each of two entry chambers of the fitting, these elements are likewise contained in sleeves insertable into the first or frontal side of the casing and they therefore likewise constitute independent units that can be easily removed and replaced.

A delivery control valve is conveniently located in an outlet from the mixer fitting, an arrangement which has the advantage of minimising the size of the cavity that must drain when the outlet opening points downwards and the water is shut off by operation of the delivery control valve.

The invention will be hereinafter more particularly described with reference to the drawings in which

Fig. 1 is a horizontal section of a mixer fitting according to the invention, comprising an entry stop valve, dirt filter and flowback preventor,

Fig. 2 is a front elevation seen from the direction II-II in Fig. 1, the cover being partly broken away,

Fig. 3 is a section taken on the line III-III in Fig. 1 of the thermostatic unit,

Fig. 4 is a section taken on the line IV-IV in Fig. 3,

Fig. 5 is a section taken on the line V-V in Fig. 3,

Fig. 6 is a side elevation of the regulator, seen in the direction VI in Fig. 3,

Fig. 7 is a section similar to that if Fig. 3 of the thermostatic unit in another embodiment, and

Fig. 8 is a section similar to that of Fig. 3 of the thermostatic unit in a third embodiment.

The illustrated embodiment of the mixer fitting or combination tap generally indicated by 1 has two openings 2 and 3 coaxially disposed parallel to the surface of a wall W into which the mixer is fitted. The openings are for making under-plaster connections with hot and cold water pipes and communicate with entry chambers 4 and 5. Openings 2 and 3 for joining the fitting to pipes above the plaster would point in a direction at right angles to the surface of the wall W. An opening 6 (Fig. 2) which extends at right angles to the major dimension of the fitting forms a bearing for the stem of a valve which carries an operating lever 7 for a delivery control valve contained in an outlet opening 14.

In the illustrated embodiment each of the two entry chambers 4 and 5 contains an entry stop valve 8 which permits the entry of water from the two supply pipes to be shut off. The valve seat 9 of each of the two entry stop valves is located in a wall portion which divides the respective entry chambers 4 and 5 into two parts, the dividing wall extending parallel to the front face of the fitting. A disc-shaped closure member 10 which cooperates with a valve seat 9 which it seals with the aid of a washer 11 made of elastically flexible sealing material is provided on the operating side with a stem 12 for actuating the closure, whereas on the other side the closure has a short projection 13 which projects through the valve seat in closing direction and carries threads permitting the entry stop valve 8 to be screwed into a web 15 in the casing.

The stem 12 is mounted in a bush 16 which can be inserted into the casing 1 of the fitting from the front. The insertable bush 16 is formed on the outside with a square fixing flange 17 which has holes in its corners for fixing screws 18 (Fig. 2) that engage corresponding tapped holes in the wall of the casing. Behind the flange 17 the bush 16 carries an outer O-ring seal that makes a tight joint. Inside the fitting the bush has an annular shoulder which bears against a corresponding annular face in the casing with the formation of a tight seal by an interposed washer 20.

Machined into the wall of the bush 16 in front of the annular shoulder are entry openings 21 and behind the annular shoulder outlet openings 22. The entry openings in the described embodiment are provided in a wall portion of the bush 16 which tapers towards the valve seat 9 and surrounding these openings there is provided a cylindrical filter 23 which retains coarse impurities contained in the entering water.

The edges of the filter screen may be soldered or welded to the bush.

On the inside of the bush 16 the entry openings 21 are covered by a rubber or like washer 24 which flesibly yields to allow the passage of inflowing water, but which prevents return flow of the water by applying itself firmly to the edges of the entry openings.

In the described embodiment the edge of the washer facing the valve seat 9 is tightly gripped by a sleeve 25 screwed into the bush 16. The stem 12 of the entry stop valve passes rotatably and axially shiftably through the tapped sleeve 25, an O-ring providing a seal from the outside. The end of the stem 12 which is accessible in a central countersink of the tapped sleeve 25 is slotted for application thereto of a screwdriver.

In the embodiment described, the valve stem 12 contains an axial threaded bore 27 which extends to the valve disc 10 and into which a fixing screw 28 for a faceplate 29 that covers the fitting in the wall W of the building can be screwed. The threaded bore 27 in the valve stem 12 may be sufficiently long to permit the edge of the face-plate 29 always to be pulled tight against the wall irrespectively of the unavoidably varying distance by which the fitting may project from the surface of the wall. Before the faceplate 29 is thus fixed it is advisable to tighten the entry stop valve in the bush 16 in its outer open position to prevent the stem 12 from being entrained when the fixing screw is being screwed tight.

After the faceplate 29 has been removed and the fixing screws 18 of the bush 16 have been undone the bush can be pulled out of the casing 1 over the valve stem 12, subject to the entry stop valve being closed, and access can then be gained to the dirt filter 23 for cleaning.

The threaded holes for the fixing screws of the faceplate 29 may, if desired, also be provided in the body of the fitting itself.

Provided side by side in two bores parallel to these valve axes between the two entry stop valves, the body 1 of the fitting contains a thermostat generally designated 30 and a pressure equaliser generally designated 31 each contained in a respective bush 32 and 33 which are each insertable into the fitting from the front, in an analagous way as above described with re-

ference to the bushes 16.

In the illustrated embodiment the thermostat is located alongside the hot water entry chamber 4 and the pressure equaliser alongside the cold water entry chamber 5.

The thermostat 30 can be set in conventional manner to the required temperature of the mixed water by a rotatable knob 34 on the face of the fitting. The fitting bush 32 of the thermost, in conventional manner, contains a temperature-responsive expansion member and a regulating element controlled thereby for adjusting the supply of hot and cold water. Inside the mounting bush 32 is a mixing chamber containing the expansion member.

In the illustrated embodiment the hot water enters the mixing chamber through a channel 35 on the back of the casing, whereas the cold water enters through a channel 37 and wall openings 38 at the other end of the mounting bush to the outlet opening 14.

The mounting bush 32 is sealed in the casing from the outside, and also between the entry openings 36 and 38 and the outlet opening 39 for the mixed water by O-rings 40, 41 and 42. The mounting bush 32 is provided with a square flange 43 in the same way as the mounting bush 16, the flange being affixable to the face of the casing 1 by screws 44.

Advantageous forms of construction of the thermostat will be later described with reference to Figs. 3 to 8.

The cavity for the mounting bush 33 of the pressure equaliser 31 is divided into two chambers 46 and 47 by a tranverse partition 45. A valve stem 48 slidably passes through the partition 45 in which it is sealed by an O-ring 49. In the relatively remote end walls of the two chambers 46 and 47 valve seats 50 and 51 are provided, which cooperate with valve closure members 52 and 53 mounted on the valve stem 48. The mounting bush 33 is sealed in the casing 1 by O-rings 54, 55, 56 and 57 and affixed to the face of the casing with the aid of a square flange 59 and fixing screws 60 in the same way as the mounting bush 32 of the thermostat 30.

The valve stem 48 passes through the valve seat 51 nearest the face of the casing as well as through an adjoining chamber 61, its end being attached to a control member in the form of a diaphragm 62. The edge of the diaphragm 62 is gripped between two lap-seamed sections of the mounting bush 33 of which the outer section carries the square fixing flange 59 and forms a control chamber 63 on the outside of the diaphragm. The valve stem 48 is itself traversed by a longitudinal duct 64.

The chamber 46 of the mounting bush 33 in the embodiment described is in communication through wall openings 66 and a duct 65 shown in Fig. 1 in chain lines with the entry chamber 4 for hot water whereas the chamber 47 communicates through wall openings 67 with the entry chamber 5 for cold water. In other words, the hot water flows through chamber 46, the valve seat 50 and the duct 35, whereas the cold water flows through chamber 47, the valve seat 51, the chamber 61 behind the diaphragm 62, the wall openings 69 of the mounting bush and a duct 37 into the mixing chamber of the thermostat 30. One side of the control diaphragm 62 is therefore exposed exclusively to the cold water so that its useful life is long.

Assuming for instance that the entry pressure of the cold water rises above the entry pressure of the hot water, then the diaphragm 62 will be deflected into the control chamber 63 in which the pressure is the lower entry pressure of the hot water transmitted through the longitudinal duct 64 through the valve stem 48. Consequently the supply of hot water will be increased because the open cross section through the valve seat 50 becomes larger, whereas the supply of cold water through the valve seat 51 is reduced.

The square fixing flanges 17, 43 and 49 of the mounting bushes 16, 32 and 33 in the illustrated embodiment all have the same external dimensions and the holes for the fixing screws are all similarly located.

Fig. 3 is an axial section of the thermostat 30 of which Fig. 1 shown merely an external view. The hot water enters from the duct 35 through a valve seat 111 which in this embodiment is provided in one wall of the casing 1 although it might also be contained in an end wall of the mounting bush 32. The cold water enters through a valve seat 112 at the other end of the mounting bush 32. In the wall of the mounting bush 32 is the outlet opening 39 for the mixed water.

Inside the bush 32 that is fitted into the casing 1 a hollow cylindrical regulating member 114 is slidably disposed between the two coaxial valve seats 111 and 112. At its ends this member has valve cones 115, 116 which co-operate with the valve seats. The valve cone 115 associated with the hot water valve seat 111 is formed on a threaded plug 117 for structural reasons.

The regulating member 114 is provided on its outside with radially projecting axial fins 118, 119, 120 (Fig. 5) which guide the member in the mounting bush 32. In the wall of the regulating member 114 on diametrically opposite sides are an entry opening 121 and outlet openings 122. The latter register with an outlet opening 39 in the wall of the mounting bush 32 and provide communication with the space be-

tween the two axial fins 118 and 119, which is closed at both ends by transverse webs 123. The fin 120 is necessary to keep the regulating member 114 centralised in the bush 32. In this arrangement the fins 118, 119 and the webs 123 divide off a mixing chamber 124 around the wall of the regulating member 114, said chamber communicating through the valve seats 111 and 112 with the entry chambers, as well as an outlet chamber 125 communicating with the outlet openings 122. In order to prevent the regulating member from turning inside the bush 32 it is longitudinally guided by a stud 126 which is screwed into its wall and slidably engages the slop-shaped outlet opening 39 in the mounting bush 32.

Inside the hollow interior of the regulating member 114 the screw plug 117 axially locates a temperature-responsive expansion member, generally designated 127. In the described arrangement the mixed water which flows transversely through the regulating member 114 completely immerses the expansion member 127.

The expansion member 127 in the described embodiment is a conventional thermostatic expanding element in which, inside a completely sealed case 128, a rubber sac 130 which is externally surrounded by the expanding material 129, such as wax, embraces a thrust pin 131 which is axially displaced by the thermal movements of the expanding material 129.

The thrust pin 131 is movably guided in a neck 132 which passes through the operative end face of the regulating element 114 and forms part of a cover 133 tightly lap sealed to the casing 128 and thereby gripping the edge of the rubber sac 130.

In the embodiment described, the neck 132 of the expansion member 127 also passes with the interposition of an O-ring seal 135 through the entry chamber preceding the valve seat 112. Consequently the thrust pin 131 is not exposed to the water and no water can seep through the guide means of the pin into the interior of the expansion member.

The expansion member could also be constituted in conventional manner by a metal bellows filled with an expanding fluid or by a stack of bimetal dish springs without in any way impairing the advantage of the expansion member of being compactly housed inside the regulator.

The free end of the thrust pin 131 bears on an adjustable spindle 136 which threadedly engages an external extension 137 of the cover 133. The setting spindle 136 can be rotated by a knob 34 which is connected thereto by a coupling sleeve 139. The coupling sleeve 139 which is firmly affixed to the rotary knob 34 is axially located in the axial extension 137 of the mounting bush 32 by a threaded ring 140. The coupling sleeve 139 is engaged by an externally non-circular, for instance hexagonal, extension 141 of the setting spindle 136. Consequently the knob does not axially move when it is turned. The thrust pin 131 of the regulating member 114 is kept in operative contact with the setting spindle 136 by a compression spring 145.

When the setting spindle 136 is axially displaced by rotation of the knob 34 the regulating member 114 approaches the valve seat 111 and moves away from the valve seat 112, or conversely, according to the hand of rotation. The temperature of the mixed water which is thus coarsely adjusted is corrected and finely regulated by virtue of the thrust pin 131 being axially displaced by the movements occasioned by the thermally expansible material 129 thereby modifying the setting of the regulating member 114.

A longitudinal bore of the setting spindle 136 contains a compression spring 148 which keeps a bearing plate 149 for the thrust pin 131 in position. The compression spring 148 is more powerful than the compression spring 145 and will yield only when adjustment of the regulating element 114 meets an unusually high resistance that might lead to fracture of the material.

In conventional manner the rotary knob 34 can be coupled to a graduated ring in any desired angular position. For this purpose the knob 34 is provided with a clamping screw 151 which projects from a countersunk opening in the knob into an annular groove 152 in the graduated ring 150. The graduated ring 150 also overlaps a sleeve 155 which is affixed to the extension 137 of the mounting bush 32 by a screw 154, and which carries an index mark for cooperation with the graduated ring 150. By loosening the screw 151 the graduated ring 150 can thus be adjusted in relation to the index mark on the sleeve 155 by reference to the temperature of the water measured at the outlet of the mixer fitting. In the transverse bore of the graduated ring 150 a press button 158 is provided which in conventional manner can be depressed against the resistance of a restoring spring 157. In position of rest a transverse pin 159 on the button limits the angular rotation range of the knob 34 by striking a stop 160 projecting from the end face of the sleeve 155. As is conventional the limitation of the angle of rotation is so chosen that a temperature of the mixed water exceeding for instance 40°C cannot be selected, thus excluding the possibility of a user being scalded. Nevertheless, in order to enable higher temperatures of the

mixed water to be selected the press button must be depressed into the position shown in Fig. 3 in which the stop pin 159 is able to clear the stop 160.

In the embodiments of the thermostat shown in Figs. 7 and 8 the expansion member is an expandable element of the kind in which the expanding substance acts by the deflection of a diaphragm on a thrust pin 131 bearing on a setting spindle.

Here a base member 202 of the expandable element which is generally indicated by reference number 201 is threadedly firmly attached with the interposition of a diaphragm 203 consisting of a flexible elastic material, to the regulating element 204 that controls the relative volumes of hot and cold water that are combined. The regulating element is sealingly movable between the two entry chambers 210 and 211 in a mounting bush that is indicated as above by reference number 32 and that is fixed in the casing 1 or the mixer fitting.

The regulating element 204 has the form of a hollow piston and in a hub 205 axially extending from its base it contains a thrust pin 131. The expanding member 201 which is connected to the regulator 204 is biased in a mixing chamber 220 connected through wall openings 207 in the mounting bush 32 with the outlet chamber 208 of the casing 1, by a spring 209 which keeps the thrust pin 131 in permanent contact with the setting spindle 136 in the manner that has already been described.

The regulator 204, which according to the adjustment of the setting spindle 136 controls the relative entry cross sections from the entry chambers 210 and 211, forms a knife edge in cooperation with a weir 213 limiting the cross section of flow from the entry chamber 210. At its end connected to the expansion element 201 the regulator 204 has a cone-d surface 214 which faces a valve seat 215 between an entry chamber 211 and the mixing chamber 220. In the end wall of the regulator 204 provided with the cone surface, a few downwardly angled bores 216 are provided through which the water flows from the entry chamber 210 into the mixing chamber 220. An intimate mixture of the two streams of water in the mixing chamber is thus assured.

In the described embodiment the base portion 202 of the expansion element 201 forms a small chamber in front of the diaphragm 203. This chamber communicates with small feeler tubes 218 which have sealed ends and are soldered into the base member. The cavities in the base member 202 and in the feeler tubes 218 are filled with the expanding material, such as wax, or a wax incorporating a metal powder, and form the expansion chamber.

Owing to the subdivision of the chamber containing the expansion material into a number of feeler tubes of small diameter a temperature responsive element is created which responds quickly to temperature changes since a relatively large surface area is available for the transfer of heat to the expanding material and the several tubes each contain only a little expandable material in which the radial thermal conduction path is short.

At least two and preferably four to six feeler tubes 218 are provided.

In the embodiment according to Fig. 7 the feeler tubes 218 are relatively parallel. The bundle of feeler tubes is situated inside the coiled compression spring 209 which maintains contact with the setting spindle.

The embodiment in Fig. 8 merely differs from that in Fig. 7 in that the feeler tubes 218 diverge conically from the base member 202. In this arrangement the coiled compression spring 209 bears on the expandable element 201 inside the bundle of tubes.

WHAT WE CLAIM IS:—

1. A thermostatically controlled mixer fitting for hot and cold water adapted to be fitted in or adjacent to a wall and including a thermostat which is adapted to be preset from a first side of the casing of the mixer fitting, said first side, when the fitting is fixed in operative condition, being adapted to face away from the wall, and which thermostat comprises a mounting sleeve containing an associated temperature-responsive element and coaxially with the latter a regulating element for adjusting the supply of hot and cold water, the thermostat being insertable from the said first side into a mixing chamber of the casing and the fitting also including a pressure-balancing unit for regulating the flow rates of the hot and cold water streams according to their pressure differential, the pressure-balancing unit comprising a mounting sleeve containing a diaphragm which is subjected in use, to the pressures of the two streams of hot and cold water and which controls a flow regulating member also located in the latter sleeve, the pressure-balancing unit being insertable into the mixer body with its axis parallel with the thermostat and from the same side as the thermostat.

2. A mixer fitting according to claim 1, in which each of two entry chambers, respectively for the hot and cold water, of the fitting contains an entry stop valve in a mounting sleeve which is also insertable into the casing of the fitting from the said first side.

3. A mixer fitting according to claim 2,

in which each valve mounting sleeve contains also a dirt filter and a flowback preventer.

4. A mixer fitting according to any one of the preceding claims having an outlet valve located in an outlet of the mixer fitting.

5. A mixer fitting according to Claim 3 or 4 when dependent on 3, in which each entry stop valve has a stem which is guided between entry openings and outlet openings in the wall of its mounting sleeve, the latter said sleeve being sealed in the casing an provided with the filter in the form of an external cylindrical screeen preceding the entry openings and internally with a rubber or like washer that yieldingly covers the entry openings in the direction of flow and prevents return flow, the entry stop valve having threads on a short projection of the stem extending from the closure member of the valve and which in valve closing direction projects through the opening of a valve seat and threadedly engages a web member in the casing.

6. A mixer fitting according to any one of the preceding claims 2 to 5 in which each entry stop valve stem is end-slotted for the application thereto of a screwdriver and has an axial tapped bore for the reception of fixing screws for a cover plate.

7. A mixer fitting according to any one of the preceding claims in which the mounting sleeve of the thermostat and the mounting sleeve of the pressure balancing unit are each formed with substantially rectangular, e.g., square, flanges of like external dimensions affixable by fixing screws to the said first face of the casing and are sealed in the casing by O-rings.

8. A mixer fitting according to Claim 7 in which the mounting sleeves for the entry stop valves are also formed with rectangular, e.g., square, flanges of substantially the same dimension as those of the mounting sleeves for the thermostat and pressure balancing unit.

9. A mixer fitting according to any one of claims 2 to 8 in which the mounting sleeve of the pressure balancing unit is divided into two chambers, each communicating with one of the two entry chambers in the casing, by a partition through which a valve stem slidably and sealingly passes, said chambers being provided in their relatively remote ends with valve seats cooperating with valve closure members affixed to the valve stem, said stem passing through that one of the said valve seats which is nearest the said first face of the casing as well as through an associated outlet chamber where its end is attached to the said diaphragm which separates the said outlet chamber from a control chamber communicating through a longitudinal bore in the valve stem with a duct in the casing remote from the said first face of the casing.

10. A mixer fitting according to claim 9 in which the valve seat through which the hot water enters a respective said chamber of the pressure of balancing unit is located in an end wall of the mounting sleeve of that unit remote from the diaphragm.

11. A mixer fitting according to any one of claims 1 to 10 in which the temperature-responsive element of the thermostat is arranged so as to be immersed in the mixed water and transmits its thermal expansions to the regulating element which is hollow and has two valve cones for controlling two entry openings, and which is adjustable by a setting spindle against the resistance of spring means, said temperature responsive element being located in a chamber of the regulating element through which the water flows transversely, while a thrust pin of the temperature responsive element projects from one end wall of the regulating element and bears on the setting spindle.

12. A mixer fitting according to claim 11, in which the regulating element is guided in the mounting sleeve of the thermostat.

13. A mixer fitting according to claim 12 in which the regulating element has external radially projecting guiding fins for guiding it in the mounting sleeve of the thermostat, said fins, with a wall containing the entry opening and the outlet opening for the mixed water, dividing off a chamber within the element in which hot and cold water are mixed from an outlet chamber communicating with the outlet opening.

14. A mixer fitting according to any one of the preceding claims 11 to 13 in which the thrust pin bears against the setting spindle through an interposed compression spring which is so dimensioned that it will yield only when an unusually high temperature is experienced.

15. A mixer fitting according to any one claims 11 to 14 in which the temperature responsive element is formed with a neck for guiding the thrust pin which passes through the end wall of the regulating element.

16. A mixer fitting according to any one of the preceding claims 11 to 15 in which the temperature regulating element contains an expansible substance in which the thrust pin is enclosed inside a rigid casing within a rubber sac enveloped by the expansible substance.

17. A mixer fitting according to any one of claims 1 to 10 in which the thermostat has an element containing an expansible substance which serves as the

temperature responsive element and the expansible substance acts, through a diaphragm closing an expansion chamber, on a thrust pin which maintains contact with a setting spindle, and in which one end of the element containing the expansible substance is firmly affixed to the regulating element which controls the relative rate of entry of hot and cold water and which is sealingly guided in its mounting sleeve.

18. A mixer fitting according to claim 17, in which the regulating element has the form of a hollow piston which at a free open end forms a knife edge limiting the entry of water through first port means, whereas the other end has a coned end face which faces a valve seat between second port means and a mixing chamber, and in which the cavity in the piston communicates with the mixing chamber by bores pointing obliquely outwards in the coned end face.

19. A mixer fitting according to claim 17 or claim 18, in which the expansion chamber of the temperature responsive element consists of a small chamber adjacent the diaphragm and an adjoining bundle of at least two feeler tubes.

20. A mixer fitting according to claim 19, in which four to six feeler tubes are provided in circular disposition.

21. A mixer fitting according to claims 19 or 20, in which the feeler tubes are relatively parallel.

22. A mixer fitting according to claims 19 or 20, characterised in that the feeler tubes diverge from the small expansion chamber adjacent the diaphragm.

23. A mixer fitting substantially as herein described with reference to Figs. 1 to 6 of the accompanying drawings.

24. A mixer fitting according to claim 23 modified substantially as herein described with reference to Figs. 7 and 8 of the accompanying drawings.

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Sheet 1

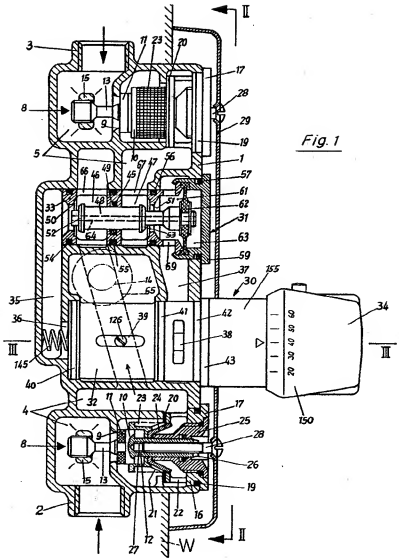

Fig. 1

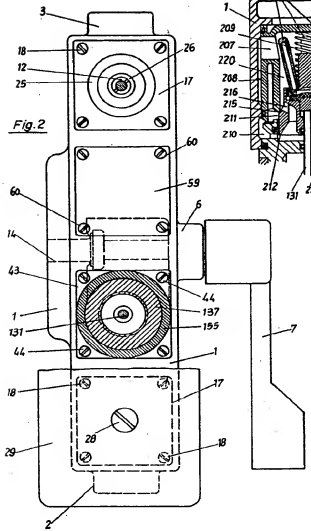

Fig.2

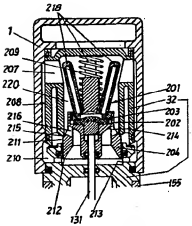

Fig.8

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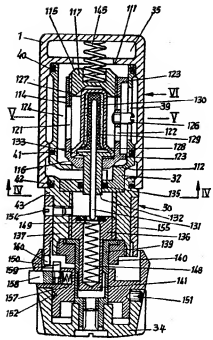
Fig.3



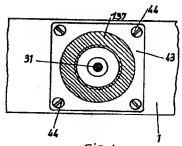


Fig.4

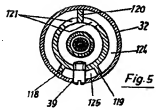


Fig.5

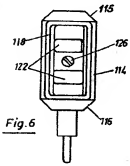


Fig.6

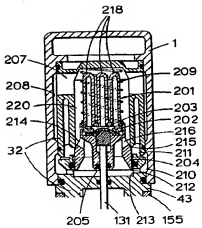


Fig.7